Back to Energy's Future?

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The Road from Agrarian to Industrial Economies*

Era	Pre-Industrial Revolution	Industrial Revolution (roughly 1750-1840)	Post-Industrial Revolution
Energy Resource	Wind, Sun, Water, Animals, Humans	Fossil Fuels	Uranium, Thorium
Energy Density (kWh per kg)	< 0.001†	< 15	> 20 million
Resource Benefits	Familiar	Mechanization of labor; major industrial development; electricity generation; vastly improved world economies; increased human lifespan	Reliable 24/7 electricity generation; safe, compact, essentially inexhaustible energy resource
Resource Shortcomings	Intermittent availability; very localized domains of use	Environmentally damaging waste; finite resources	Moderate waste impact on environment; public fear of radiation due to poor education, misinformation

* Adapted from Wade Allison, *Nature Energy and Society: A scientific study of the options facing civilization today*, March 2020; wade.allison@physics.ox.ac.uk

† One hour's work from 800 kg draft horse is about 0.0009 kWh/kg

Revisiting Energy Resources Used to Generate Electricity

Electricity-generating System Efficiencies

Comparison of electricity-generating system efficiencies:

- Coal-fired power plant – 32%
- Nuclear power plant – 34%
- Hydroelectric plant – 84%
- Photovoltaic facility – 19%
- Wind turbine facility – 36%

Electricity-generating System Average Capacity Factors

Energy System	Average Capacity Factor	Equivalent Full Power Days Per Year
Nuclear	92%	336
Geothermal	74%	270
Natural Gas	56%	204
Hydroelectric	41%	150
Coal	40%	146
Wind Turbine	35%	128
Photovoltaic	25%	91

Source: Energy Information Administration, 2020

Problems With100% “Renewables”

Renewable Resource Life-Cycle Issues

Reality of 100% “Renewables”

Eliminating fossil fuels and nuclear power require massive worldwide increase in mining for lithium, cobalt, copper, iron, aluminum, and numerous other raw materials

Producing wind turbines, solar arrays, and energy storage batteries requires mining, moving, and refining vast amounts of earth – far more than required to obtain same amount of energy from coal, oil, and natural gas[1]

Reality of 100% “Renewables” (cont.)

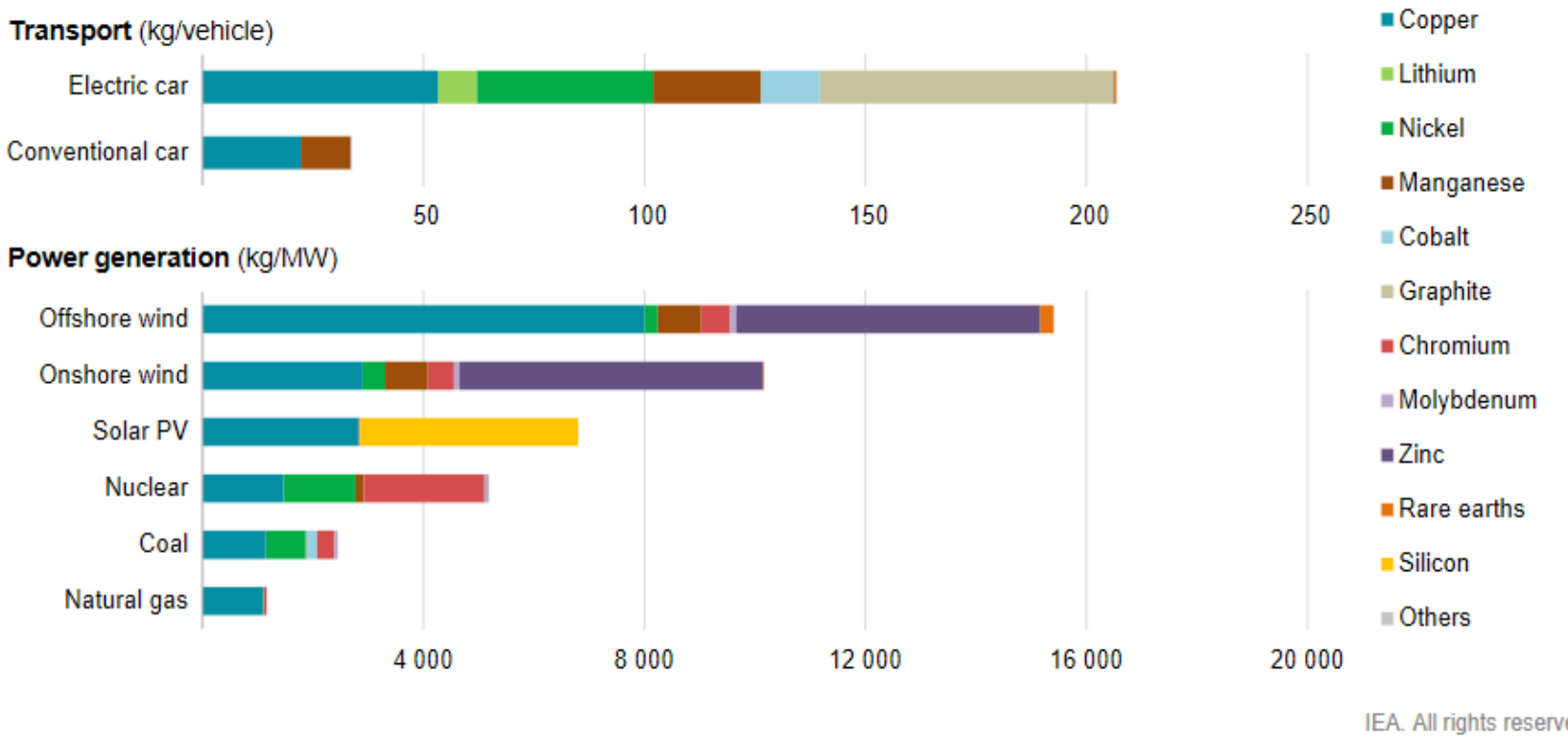
Most equipment needed to mine and transport “green” energy materials must run on diesel fuel made from oil (too big and heavy to be powered efficiently by batteries)

Missing from renewable energy discussion is $0.5 trillion (or more) cost associated with 500,000 miles (or more) of new transmission lines required to connect 50,000-plus wind and solar facilities for all-renewables grid[1]

Reality of 100% “Renewables” (cont.)

- Building wind turbines and solar panels to generate electricity as well as batteries to fuel electric vehicles requires, on average, more than 10 times quantity of materials compared with building machines for hydrocarbons to deliver same amount of energy[1]
  - World will have to initiate biggest increase in mineral and metal mining in history
- Hydrocarbon resources cannot be replaced by “renewable” energy resources
  - Hydrocarbons needed to produce concrete, steel, plastics, and purified minerals used to build “green” machines

Minerals Used in Energy Technologies



IEA. All rights reserved.

Notes: kg = kilogramme; MW = megawatt. Steel and aluminium not included.

Technology Transition Mineral Implications

- In August 20, 2021 report from Geological Survey of Finland,[1] researchers considered minerals implications for achieving power generation and transportation transition paths from fossil fuels
  - Found resulting demand for nearly every necessary mineral, including common ones such as copper, nickel, graphite, and lithium, would exceed not just existing and planned global production capabilities, but also known global reserves*
- August 2024 report[2] confirmed previous conclusions

* https://www.gtk.fi/en/current/a-bottom-up-insight-reveals-replacing-fossil-fuels-is-even-more-enormous-task-than-thought/

“Renewable” Energy Culminates in Non-recyclable Waste

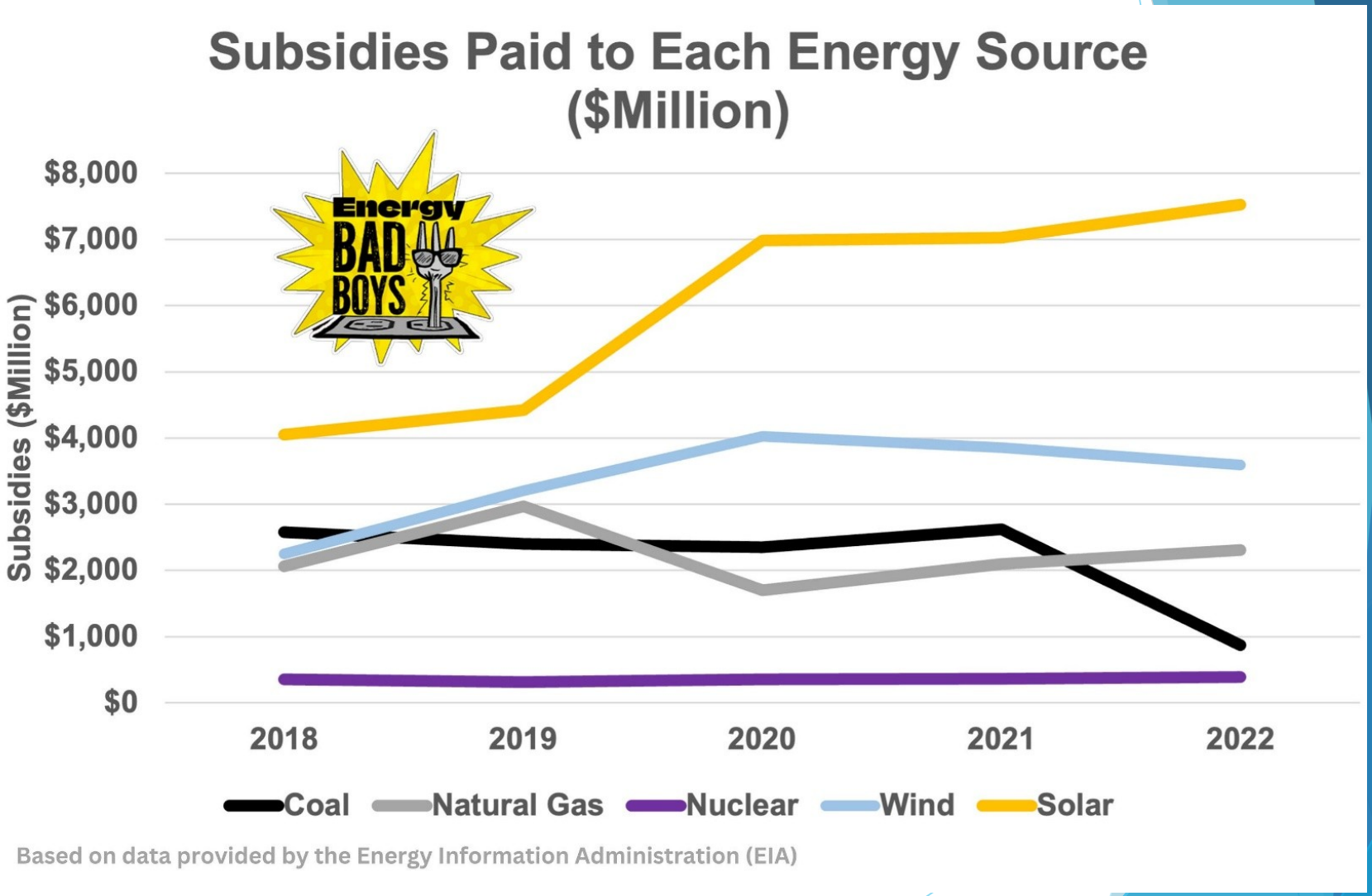
Much of the materials in renewable energy devices cannot be recycled when the devices reach the end of their life.[1]

- Old solar and wind electricity-generating equipment must be disposed of, generating millions of tons of waste, much of it toxic.
- Following a 7-year life, 1,000-pound electric car batteries must be disposed of, with major toxic waste implications.

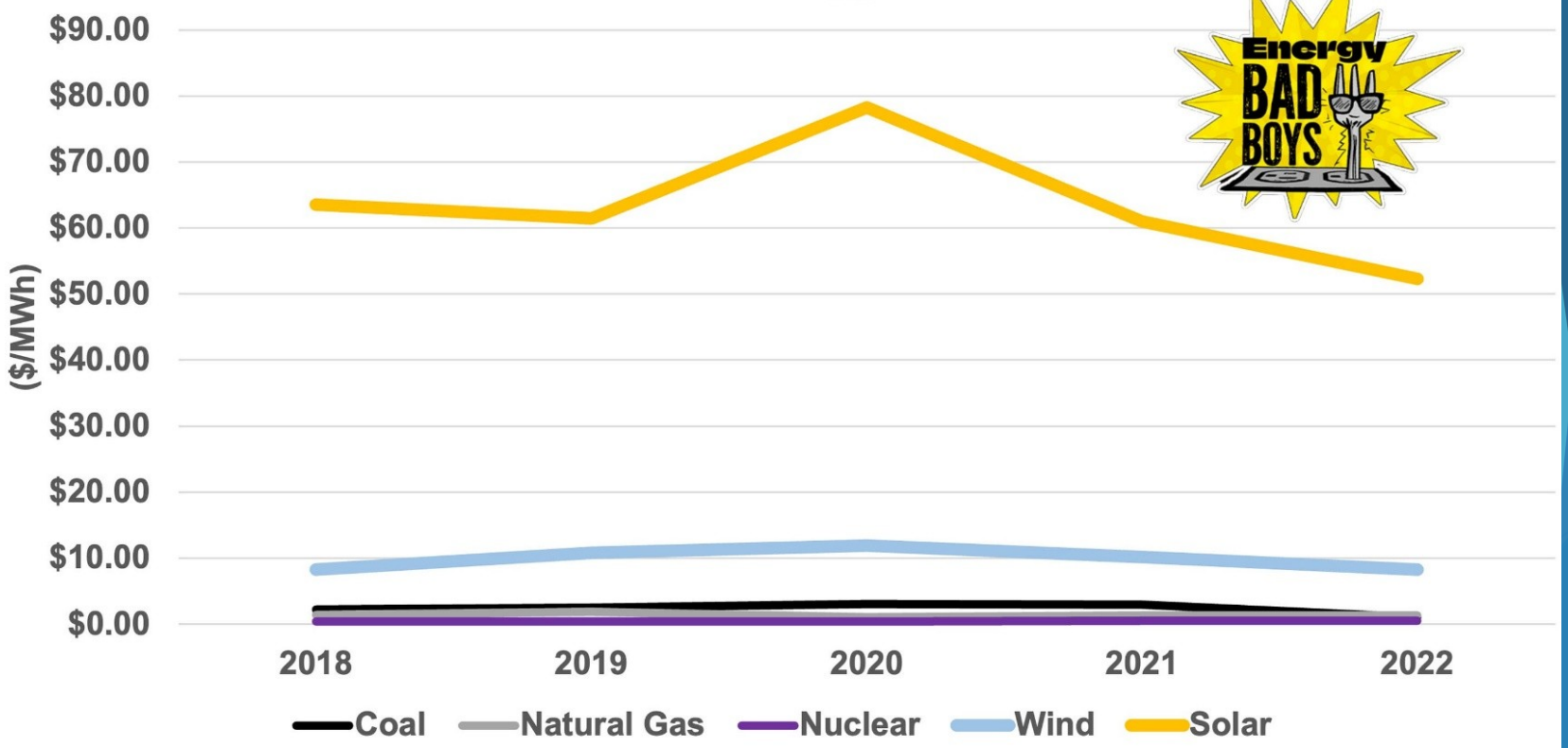
Renewable Resource Economic Issues

100% Renewables Energy Economy Not Cost Effective

- Renewable energy sources can’t survive on their own – require government subsidies to be competitive
- Renewables increase cost of electricity – require overbuilding because of low capacity factors
- Question not adequately addressed – will wind turbine ever generate as much energy as invested in building it


Subsidies Paid to Each Energy Source ($Million)
Subsidies ($Million)
$8,000
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
2018
2019
2020
2021
2022
Coal
Natural Gas
Nuclear
Wind
Solar
Based on data provided by the Energy Information Administration (EIA)

Subsidies per Megawatthour Produced ($/MWh) for Each Energy Source



Based on data provided by the Energy Information Administration (EIA)

Levelized Cost of Energy (LCOE)

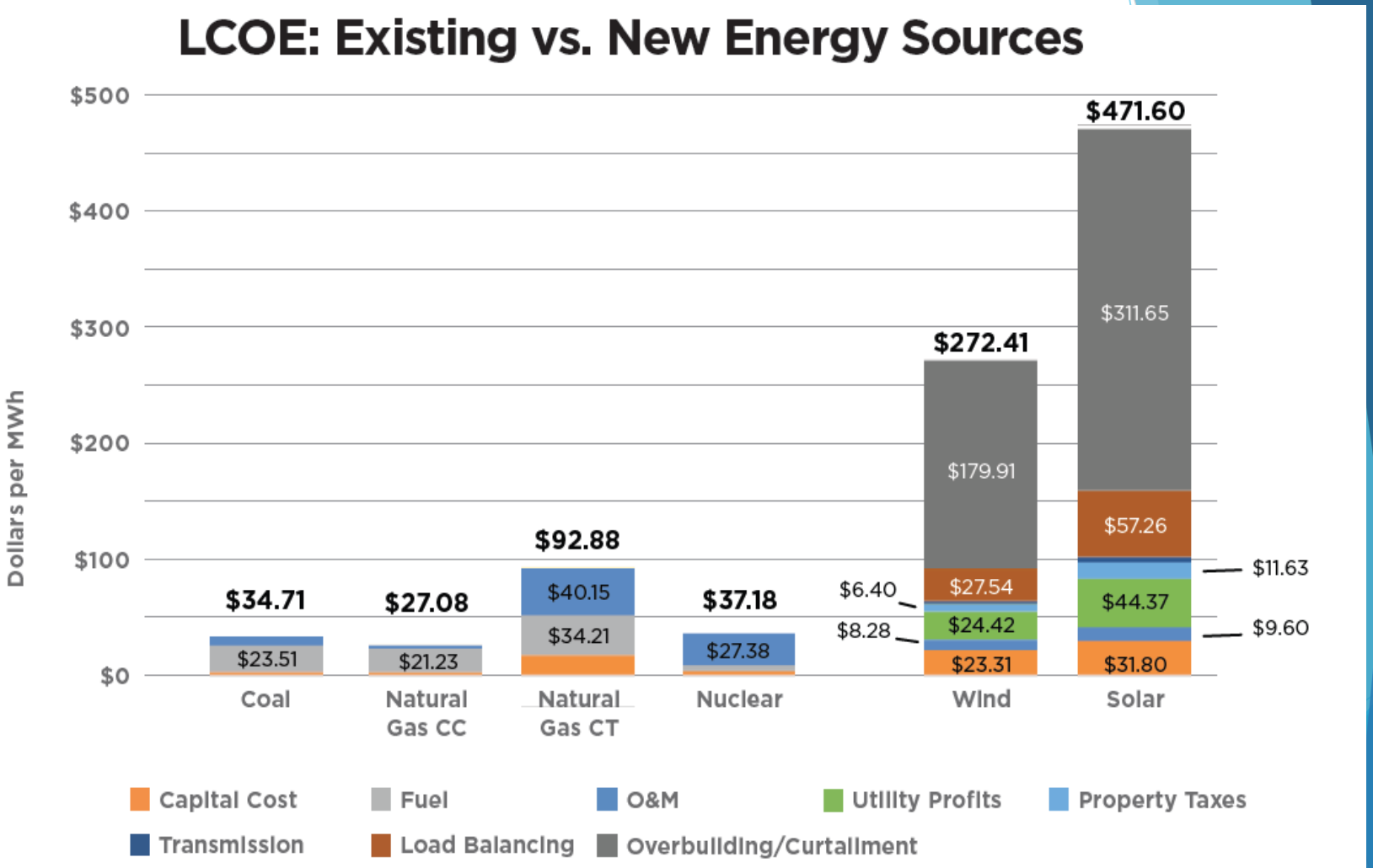
- LCOE metric often cited to support claim that solar and wind energy cheaper than fossil fuels
  - Represents average net present cost of building and operating energy-producing asset per unit of electricity generated over its lifetime
  - Allows valid comparison of resources able to provide same reliability value to grid; e.g., electricity at peak demand far more valuable than off-peak power
  - Provides distorted picture of renewable energy costs as costs associated with backup electricity sources and high-voltage transmission systems ignored
  - Does not include costs associated with additional equipment needed to maintain operational balance in power grid with intermittent renewable electricity

Levelized Cost of Energy (cont.)

- Not appropriate to compare LCOE estimates for dispatchable (i.e., available on demand) and non-dispatchable electricity sources
- Renewable (non-dispatchable) resource LCOE estimates don't cover total cost incurred by energy consumers, who also pay for
  - backup power sources to provide electricity when renewable resources not available
  - transforming grid to accommodate frequent transition to/from backup power sources

Levelized Cost of Energy (cont.)

- Wind and solar unreliability (i.e., low capacity factors) necessitate additional asset costs not included in LCOE estimates
  - Grid load balancing costs associated with backup power sources, whether natural gas or batteries
  - Overbuilding costs associated with additional renewable assets needed charge backup battery energy storage systems while simultaneously providing power to grid
  - Curtailment costs associated with reducing occasional oversupply of renewable electricity generation to maintain supply/demand balance
  - Property taxes for extensive land use



LCOE – Levelized Cost of Energy, CC – combined cycle, CT – combustion turbine

Wind Turbine Issues

Wind Turbine Land Use Issues

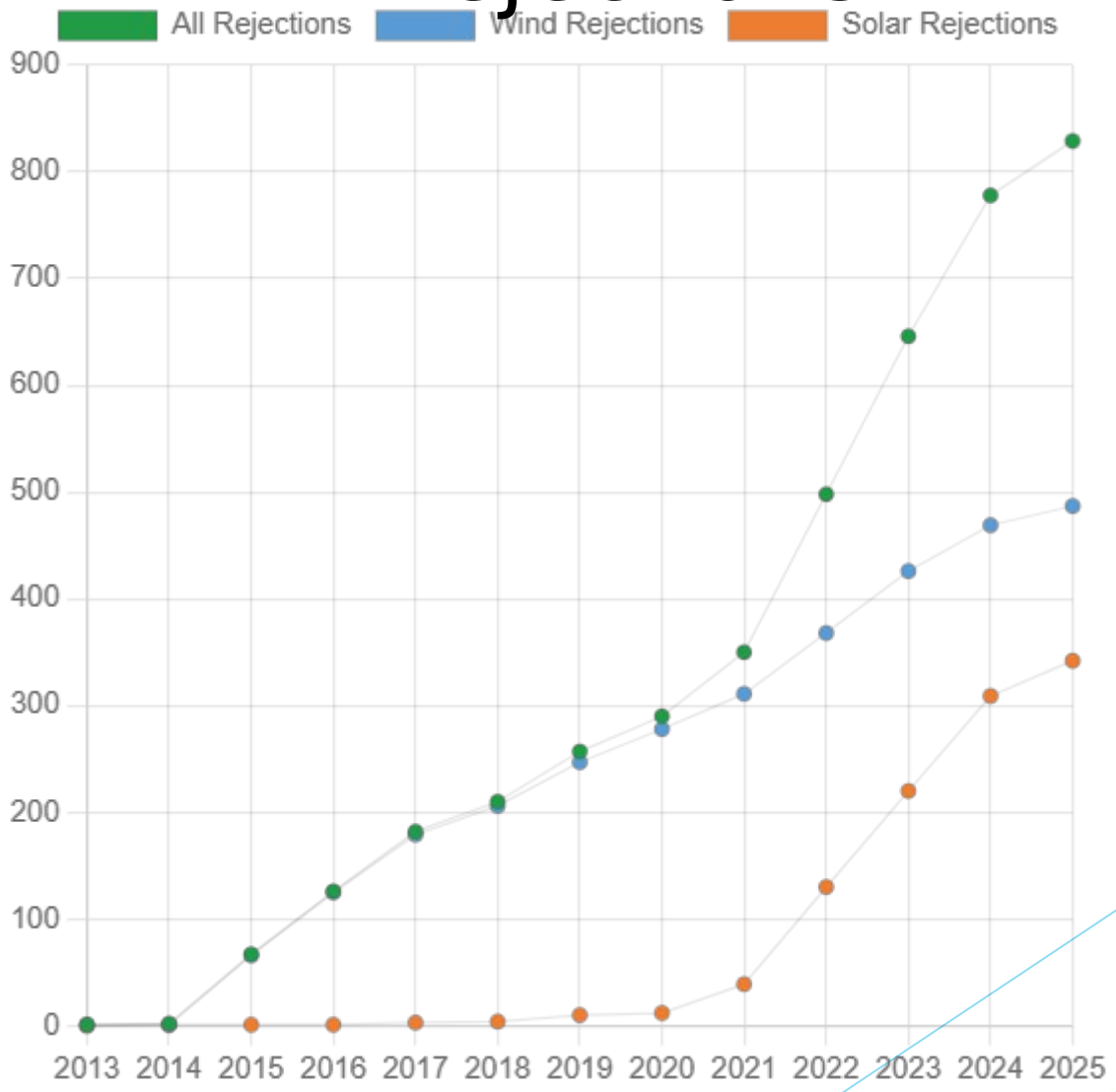
Since 2015, from Maine to Hawaii, around 500 rejections or restrictions of wind projects.*

- Wind turbines create noise pollution, both audible and inaudible low-frequency noise, which can cause sleep disturbance, dizziness, headaches, concentration and memory issues, and cardiac arrhythmia in humans†
- Wind projects invariably targeted for low-income counties where opponents don't have financial resources to fight back

* R. Bryce, *Renewable Rejection Database*, https://robertbryce.com/renewable-rejection-database/?utm_source=substack&utm_medium=email

† Jeffery RD, Krogh C, Horner B, *Adverse health effects of industrial wind turbines*, Canadian Family Physician, 2013 May; 59(5):473-5

U.S. Wind and Solar Project Rejections



Wind Turbine Environmental Issues

- Preparation of land for many wind farms does extensive environmental damage, often necessitating removal of thousands of trees and bulldozing of hills and valleys
- Wind turbine standing 300 to 500 feet tall with blade wingspan of 300 to 350 feet requires hundreds of tons of cement to anchor the base and hundreds of tons of steel that must be made from hundreds of tons of iron using hundreds of tons of coking coal

Wind Turbine Safety Issues

- Turbine blade failures have killed more than 100 people around the world in past decade

- Nearly 1,500 wind turbines have collapsed for unexplained reasons
- Wind turbines not as benign as advocates claim

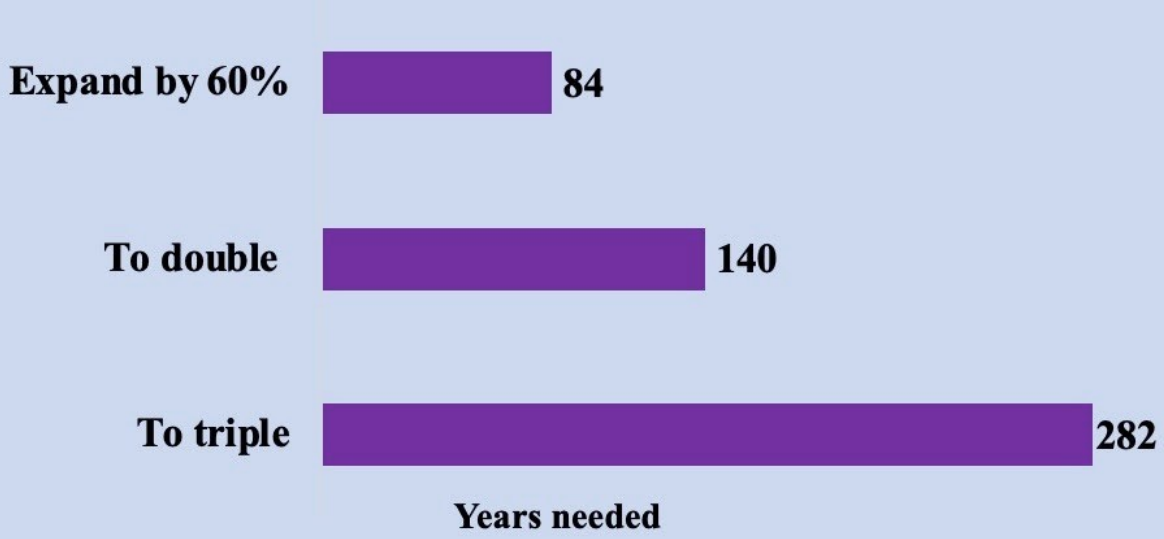
Renewable Electricity Transmission Issues

The “Renewables” Transmission Problem

Years Needed For Grid Buildout At Current Growth Rate

“...we need to expand electricity transmission systems by 60% by 2030, and may need to triple it by 2050 to meet the country’s increase in renewable generation and expanding electrification needs.”

- DOE press release, May 10, 2022



Sources: C Three Group, DOE, https://www.energy.gov/articles/biden-administration-launches-25-billion-fund-modernize-and-expand-capacity-americas-power

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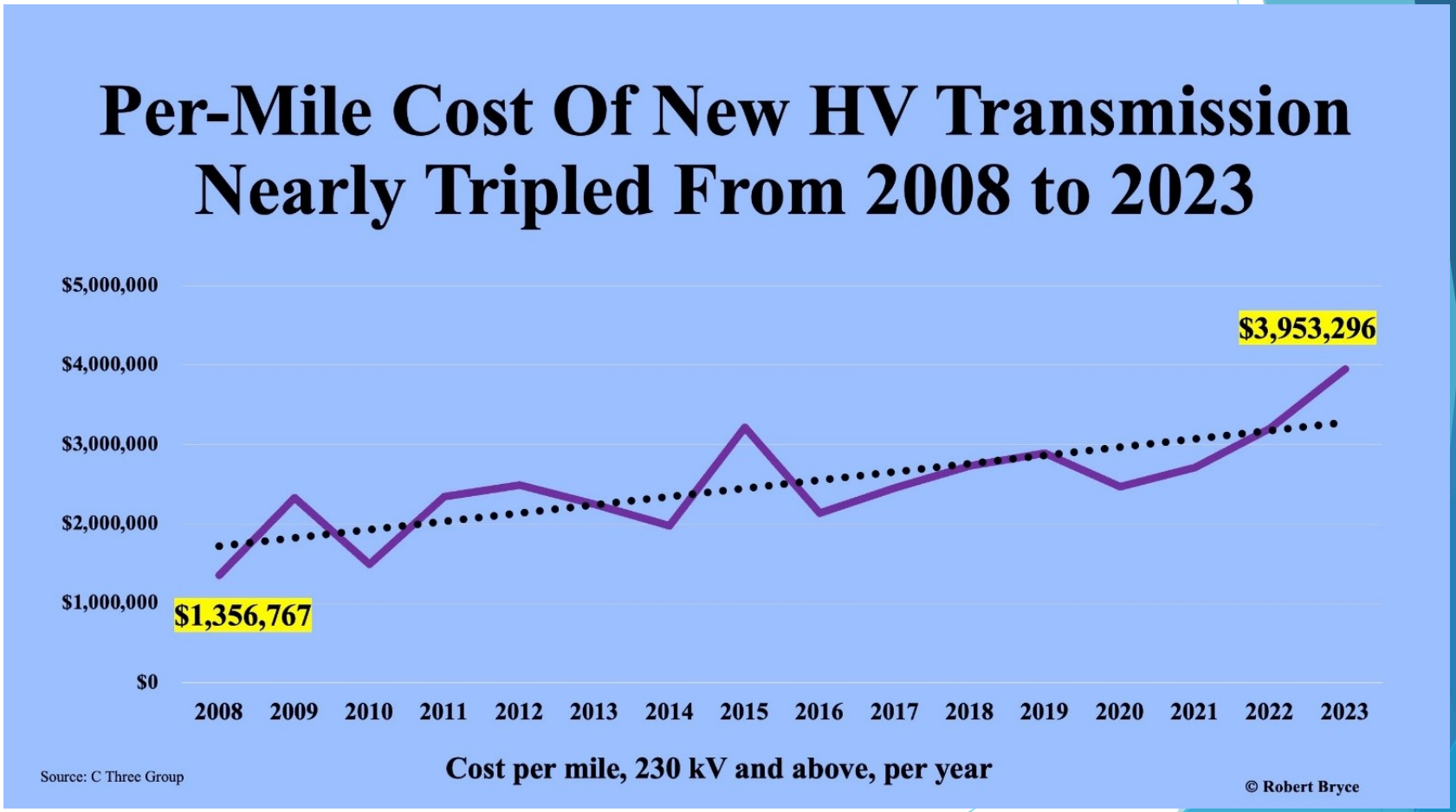
The Transmission Problem (cont.)



Battery Energy Storage Issues

The Energy Storage System Problem

There is an almost complete disconnect between current efforts of small research grants and pilot programs to investigate which of various new energy storage technologies might work in a 100% renewables scenario, and a multi-hundred-trillion-dollar total transformation of the entire energy economy that will supposedly be accomplished by 2035 using technology not yet invented, let alone demonstrated at scale.

Ref. Report on the Status of the U.S. Energy Storage Project, by F. Menton, April 7, 2022

Battery Energy Storage Issues

- Energy density defined by ability to store energy in given volume or with given mass
  - Absent major breakthroughs, energy density of best lithium-ion batteries very low – necessitates extremely large number of batteries for significant electricity storage
- Inefficient electrical-to-chemical energy conversion, storage, and reconversion (typically 83% for lithium-ion batteries[1]) necessitates more electricity generation from primary energy resources and more batteries to achieve required battery energy storage system output

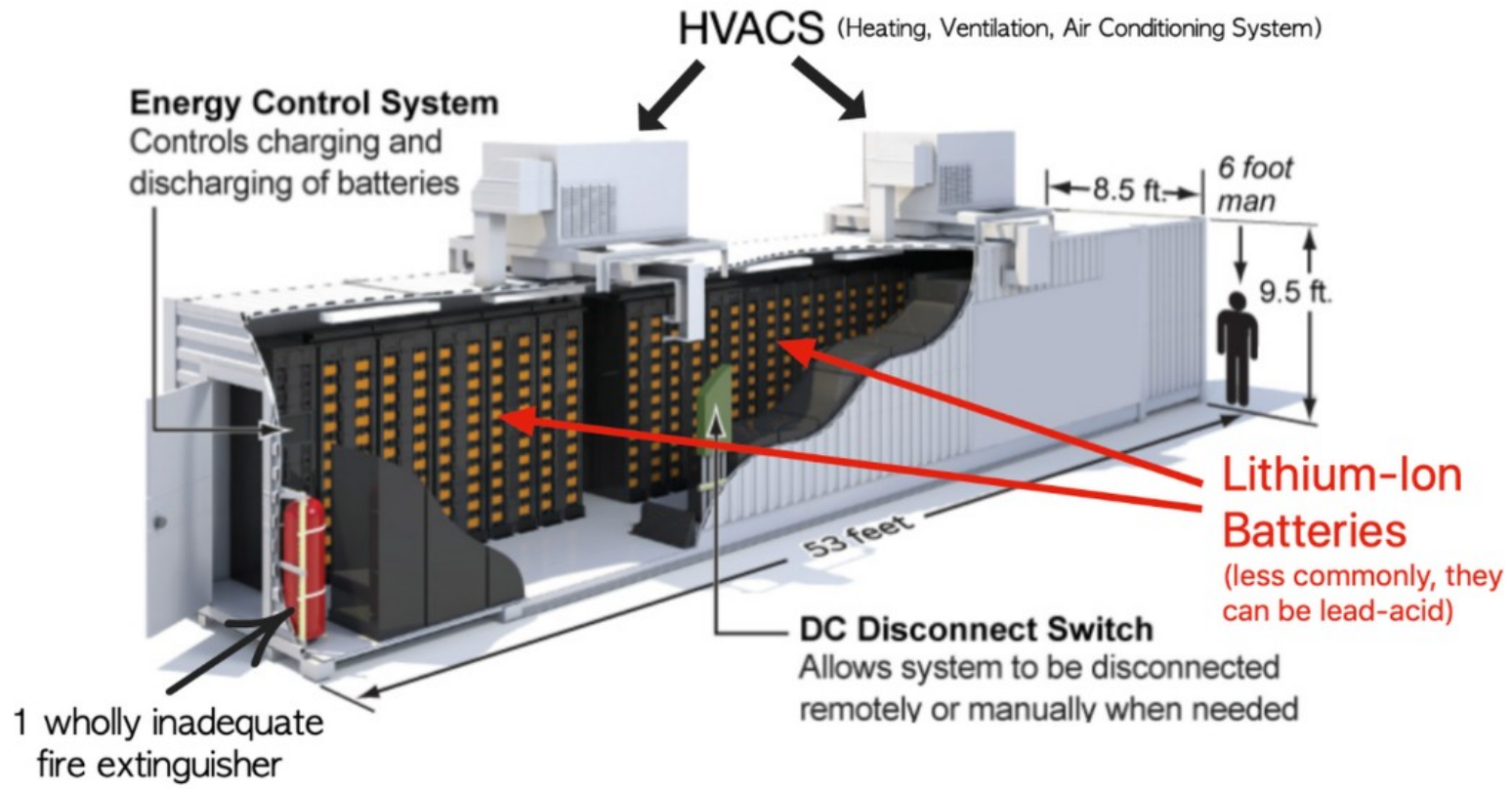
Battery Energy Storage Issues (cont.)

- Power conditioning equipment (inverters and transformers) as well as transmission lines required for integration of battery energy storage systems with distributed wind and solar facilities and with electrical grid
  - necessitate additional energy generation for equipment manufacturing, transportation, and installation
  - result in more energy losses
- Uncertain supply of critical minerals necessary for enormous increases in battery manufacturing
- Life-cycle wastes associated with battery and power conditioning equipment manufacturing

Battery Energy Storage Issues (cont.)

- Lack of critical scrutiny for Net Zero agenda associated with 100% renewables economy leads to implicit expectation that consumers and taxpayers will absorb higher costs of dramatic global expansion of battery energy storage indefinitely through government subsidies

Battery Energy Storage System


HVACS (Heating, Ventilation, Air Conditioning System)
Energy Control System
Controls charging and discharging of batteries
8.5 ft.
6 foot man
9.5 ft.
Lithium-Ion Batteries
(less commonly, they can be lead-acid)
53 feet
DC Disconnect Switch
Allows system to be disconnected remotely or manually when needed
1 wholly inadequate fire extinguisher

The Battery Problem

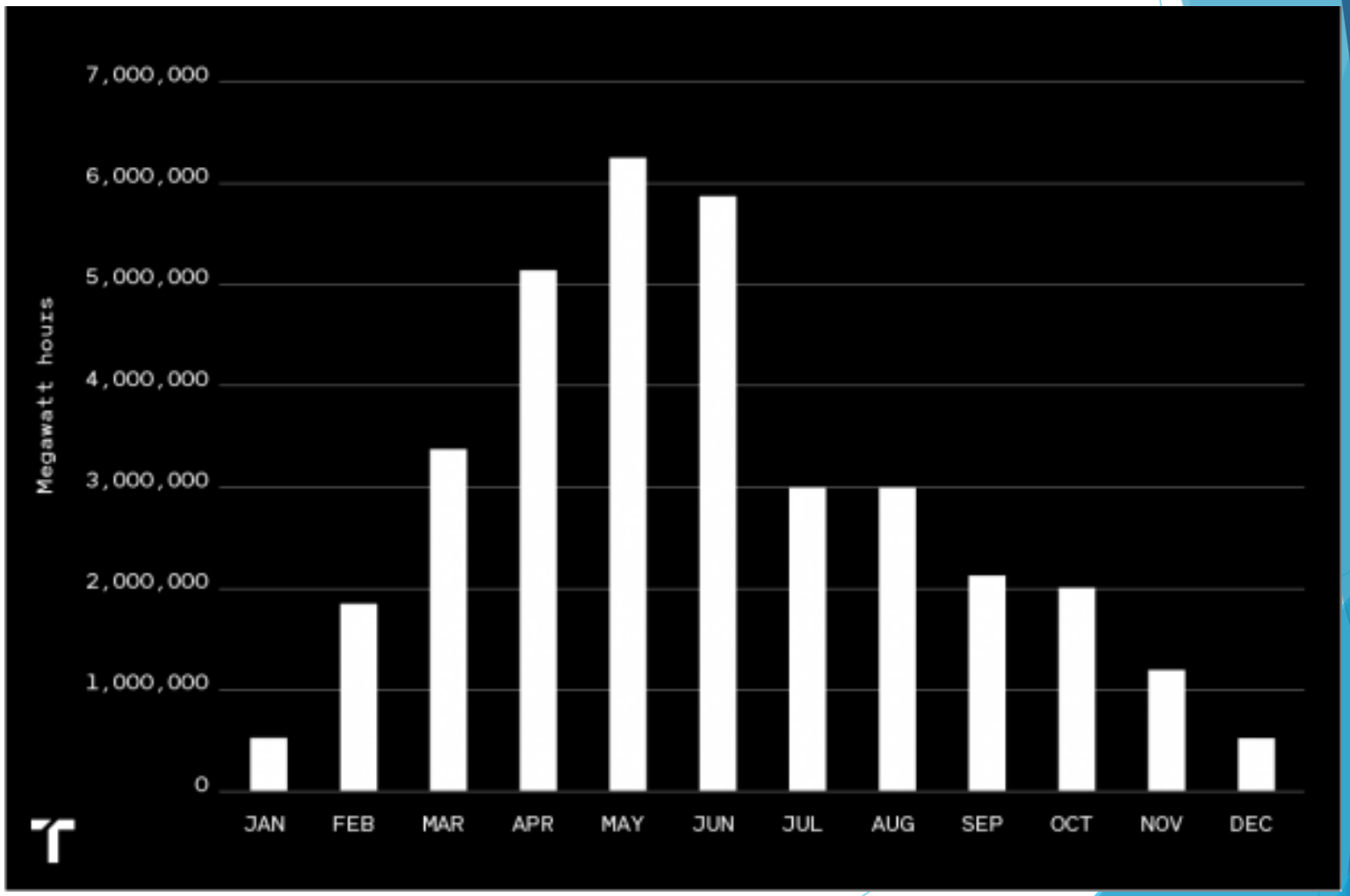
Charging backup batteries requires off-grid wind and solar energy; i.e., energy not needed to satisfy immediate electricity demands

Wind and solar facilities far in excess of that required to meet peak load demands necessary to charge all batteries needed to provide electricity when wind and sun not available

The Battery Problem (cont.)

- Off-grid system must be designed to provide charge current capable of recharging batteries quickly and efficiently, and within window of time on-grid system is generating peak power
- Lithium-ion battery energy storage systems generally designed for only few hours of energy storage – enough to accommodate daily swings in solar and wind electricity generation, but insufficient to accommodate long periods (e.g., days or even weeks) when sun and wind unavailable
- To achieve reliable 100% solar or wind electricity U.S. would need ability to store three months' worth of electricity at enormous cost
- Battery energy storage systems need to be replaced every 15 years

Battery Challenge – Variations in Wind and Solar Electricity Generation



The Battery Problem (cont.)

Backup battery storage requirements for electricity demands of entire U.S. would be absolutely staggering; issues not addressed include

- How many batteries required to provide adequate backup electricity to “green” grid when parts of U.S. experience extended wind and sun “downtimes”
- Do sufficient raw materials even exist
- How to dispose of huge amounts of toxic waste from battery manufacturing

The Battery Problem (cont.)

Efficiency of storing and recovering wind and solar energy is 60%-70% for lead-acid storage batteries and 87%-94% for lithium-ion batteries,[1] which also adds to off-grid wind and solar facility requirements

Lithium batteries contain both oxidizers and fuel within the enclosed battery space, and therefore carry risk of fire and explosion in case of overcharging, over-discharging, excess current, or short circuits

Battery Storage Reality Check

- Tesla Megapack, shipping container-sized 19.3 MWh battery energy storage system, costs more than five million dollars, or about $260 per kWh[1]
- For comparison, U.S. average cost of electricity for month of May 2021 was 13.71 cents per kWh for residential customers and 10.65 cents per kWh for all sectors of economy[2]

Tesla Megapack

9.6 MW Power

19.3 MWh Energy

Megapack Quantity 5

Megapack Duration 2 hr | 4 hr

Site Location California

Desired Delivery Date Q4 2025

Estimated Price $5,045,400
Subject to change
Taxes and installation not included

Est. Annual Maintenance $29,610
Price escalates at 2% per year

Due Today $10,000
Non-refundable Reservation Deposit

By placing a deposit, I agree to the Megapack Reservation Terms, Megapack Maintenance Agreement, and Privacy Notice

Ref.
https://www.tesla.com/megapack/design

Battery Storage Reality Check (cont.)

- Tesla Gigafactory can manufacture ≈ 50 gigawatt-hours (GWh) of battery packs per year
- Currently 5 Tesla Gigafactories
- April 2023 Tesla report[1] asserted 240 terawatt-ho (TWh) of battery storage needed for 100% renewables grid
  - requires 960 years output from 5 existing Gigafactories
  - even ten-fold expansion of Gigafactories requires 96 years of output

Battery Storage Reality Check (cont.)

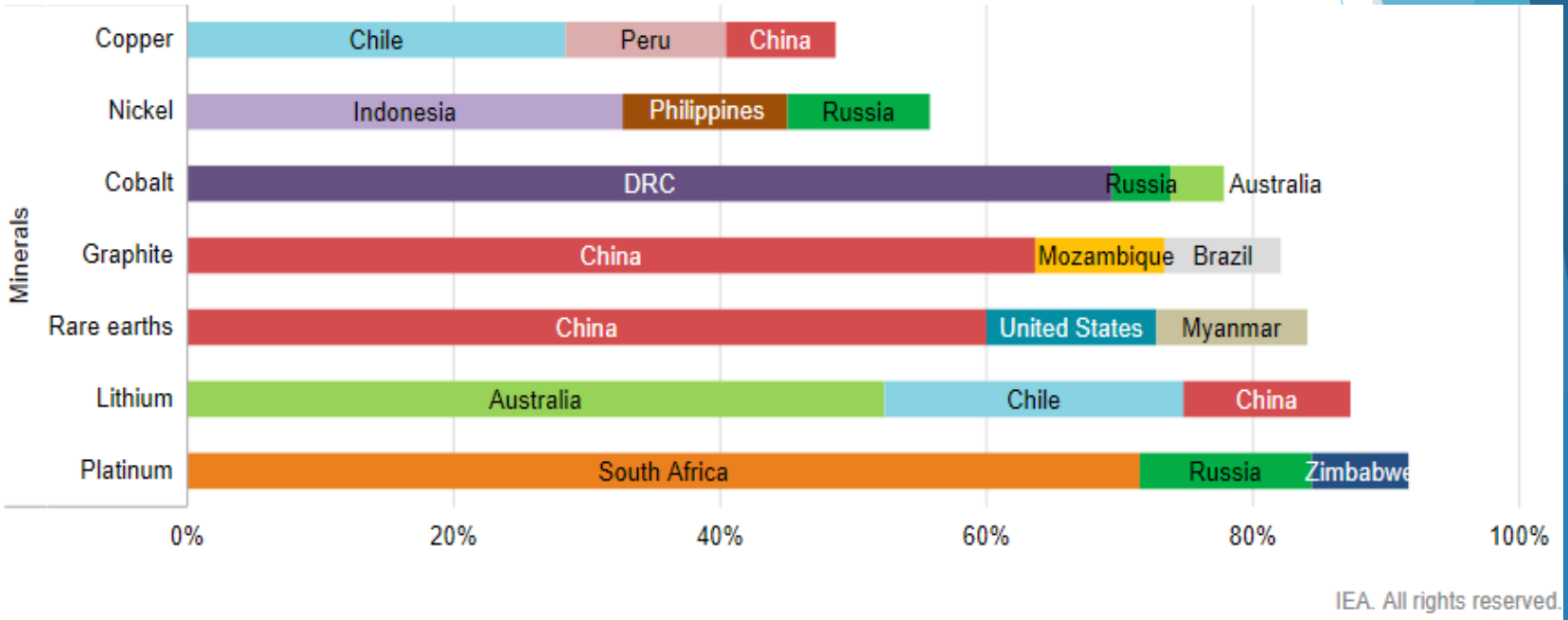
At scale necessary to supplement on-demand “renewable” generated electricity, cost of backup battery storage systems makes anything even close to 100% renewables economically impossible

Ref. Environment & Climate News, Vol. 23, No. 02, February 2020

Renewable Energy Supply Chain Issues

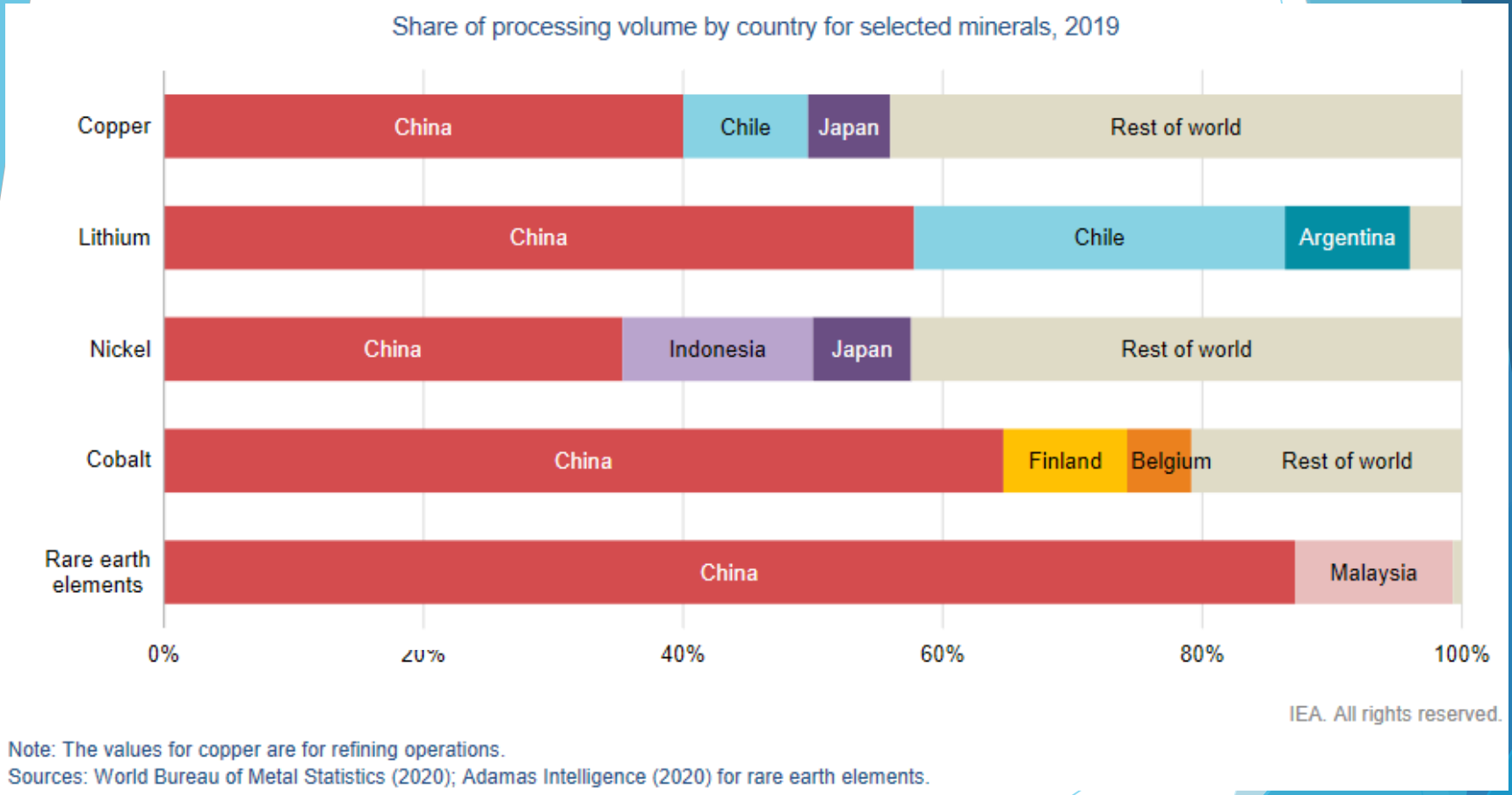
“Renewable” Energy Supply Chain Problem

Share of top three producing countries in total production for selected minerals, 2019



Sources: IEA (2020b); USGS (2021).

“Renewable” Energy Supply Chain Problem (cont.)



Note: The values for copper are for refining operations.
Sources: World Bureau of Metal Statistics (2020); Adamas Intelligence (2020) for rare earth elements.

“Renewable” Energy Supply Chain Problem (cont.)

- Five of world’s top-10 wind turbine manufacturers are Chinese-owned or operated
- Nine of world’s top-10 solar panel manufacturers are Chinese-owned or operated
- China responsible for 37% of passenger electric vehicles and 99% of e-buses sold globally since 2011

The Cost of Going Back to Pre-Industrial Revolution Energy Resources

Retreat to Pre-Industrial Revolution

False Premise: renewable energy eliminates need for fossil fuels

- Renewable energy resources can only generate electricity
- Getting rid of crude oil would eliminate more than 6,000 products in demand by hospitals, airports, communications, etc., and would paralyze virtually all transportation
- Petrochemicals are basis for virtually all consumer products that did not exist prior to 1800s

Retreat to Pre-Industrial Revolution (cont.)

- Living conditions before 1800's drastically different as world did NOT have following infrastructures and products made from oil derivatives manufactured from raw crude oil
  - Energy (electricity generation, transmission, and distribution)
  - Transportation (planes, trains, and motor vehicles)
  - Healthcare (hospitals, medical equipment, pharmaceuticals)
  - Information Technology (radio, television, telephones, computers, internet)
  - Home Appliances (esp. for heating, cooling, refrigeration)
  - Public Sanitation (e.g., waste disposal, wastewater treatment)

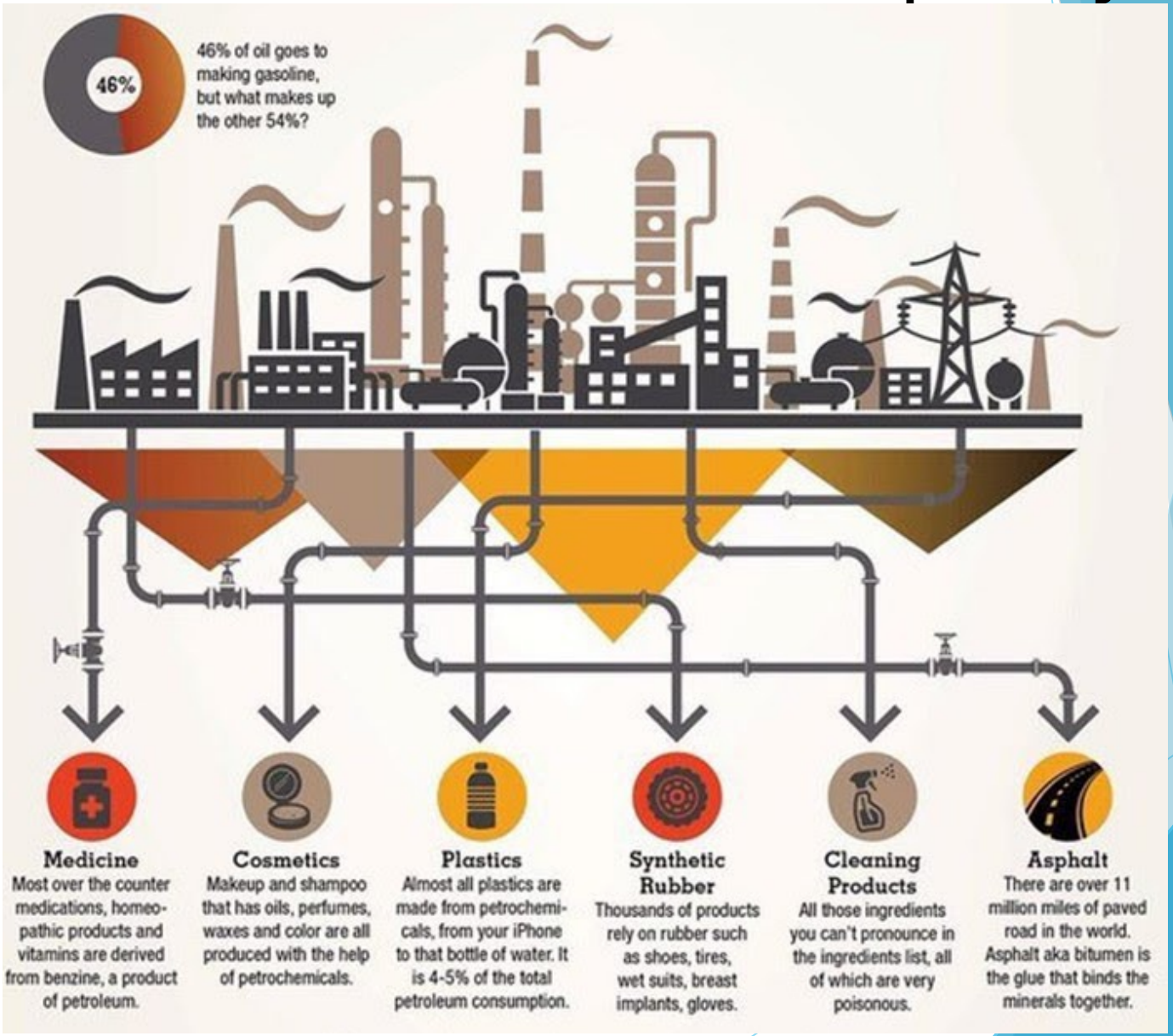
Retreat to Pre-Industrial Revolution (cont.)

- Generation of electricity from renewable energy resources dependent on oil as ALL electrical generation facilities –-- hydro, coal, natural gas, nuclear, wind, and solar --- built with products, components, and equipment made from oil derivatives manufactured from crude oil
- Believing existing solar, wind, and energy storage technologies make possible rapid and wholesale replacement of fossil fuels ignores underlying physics, engineering, and economics

Retreat to Pre-Industrial Revolution (cont.)

- If all of America's electricity generated only by "renewable" energy resources,
  - America always dependent on foreign governments for materials necessary for electricity production
  - electricity necessarily rationed; that is, brownouts and blackouts inevitable
- If all cars are electric vehicles only, insufficient electricity to keep them charged

Crude Oil Vital to Prosperity


46%
46% of oil goes to making gasoline, but what makes up the other 54%?
Medicine
Most over the counter medications, homeopathic products and vitamins are derived from benzine, a product of petroleum.
Cosmetics
Makeup and shampoo that has oils, perfumes, waxes and color are all produced with the help of petrochemicals.
Plastics
Almost all plastics are made from petrochemicals, from your iPhone to that bottle of water. It is 4-5% of the total petroleum consumption.
Synthetic Rubber
Thousands of products rely on rubber such as shoes, tires, wet suits, breast implants, gloves.
Cleaning Products
All those ingredients you can't pronounce in the ingredients list, all of which are very poisonous.
Asphalt
There are over 11 million miles of paved road in the world. Asphalt aka bitumen is the glue that binds the minerals together.

Life Without Petroleum (Video)

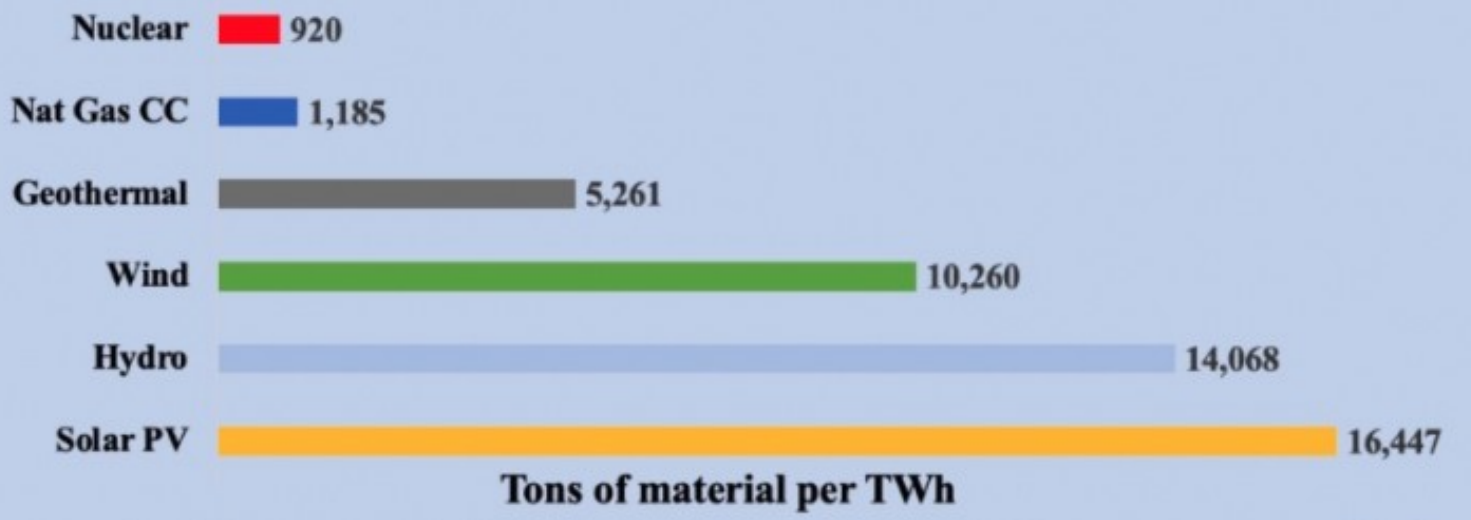
Final Note: UNECE 2021 Report

From James Conca, *Can we please stop this nonsense about what's the best source of energy?* Nuclear News, April 21, 2025

"The 2021 report *Life Cycle Assessment of Electricity Generation Options,* by the UN Economic Commission for Europe (UNECE), shows that nuclear has the lowest overall impacts on human health and the environment, by any measure and from any perspective."

Supplemental Slides

Iron Law of Power Density: The Lower The Power Density, The Greater The Resource Intensity



Source: Department of Energy, 2017. https://www.energy.gov/sites/prod/files/2017/03/f34/quadrennial-technology-review-2015_1.pdf, 390. See table 10-4.

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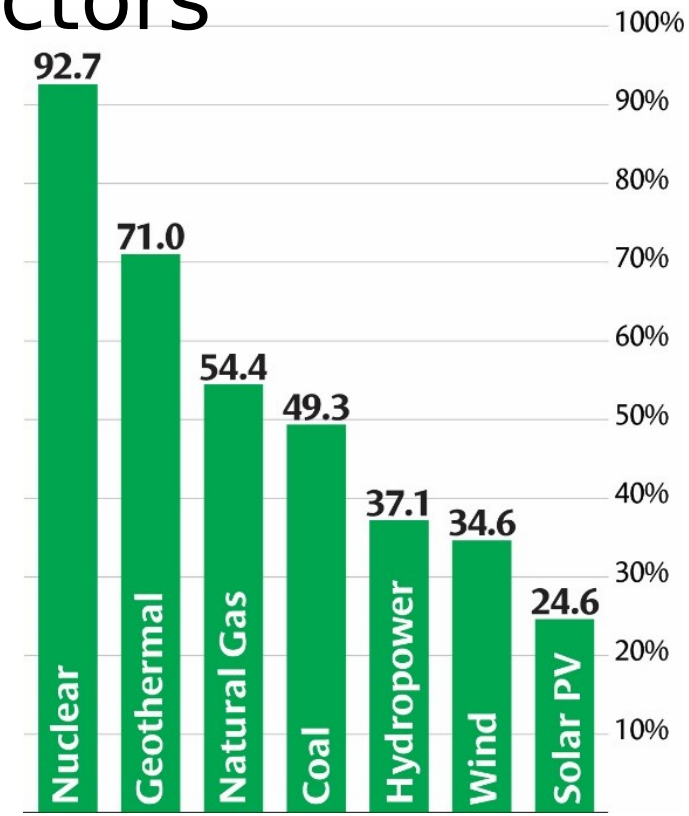
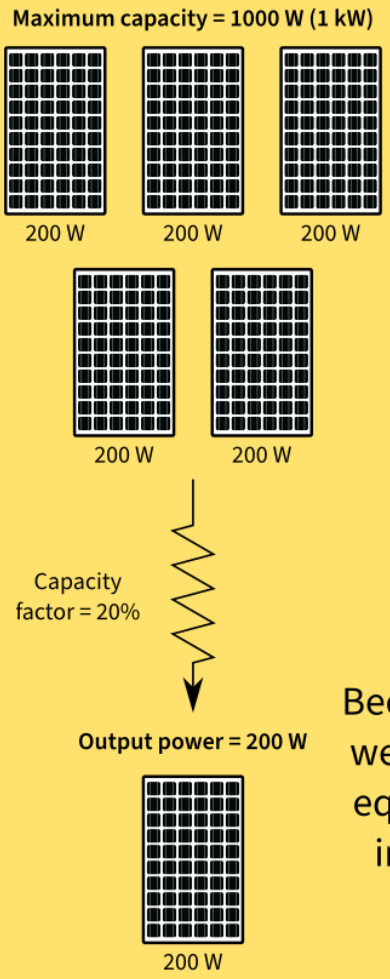
Energy System Capacity Factors



U.S. capacity factor by source, 2021 (Source: U.S. Energy Information Administration)



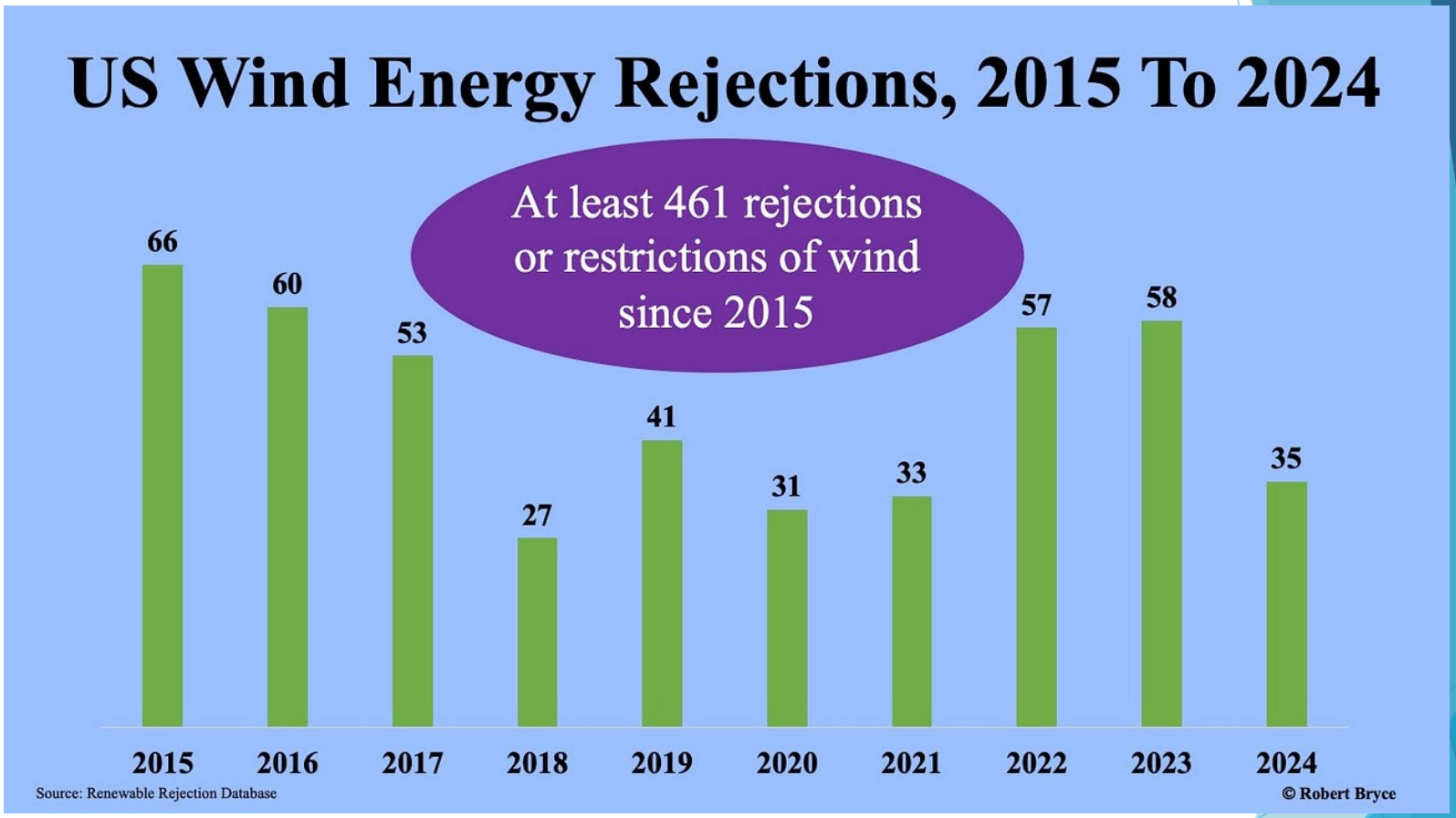
Capacity factor

$$= \frac{\text{Actual power output}}{\text{Maximum capacity}}$$

$$= \frac{200}{1000}$$

$$= 0.20 = 20\%$$

Because of the capacity factor, we only get the power output equivalent to one solar panel instead of five solar panels


US Wind Energy Rejections, 2015 To 2024
At least 461 rejections or restrictions of wind since 2015
66
60
53
27
41
31
33
57
58
35
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Source: Renewable Rejection Database
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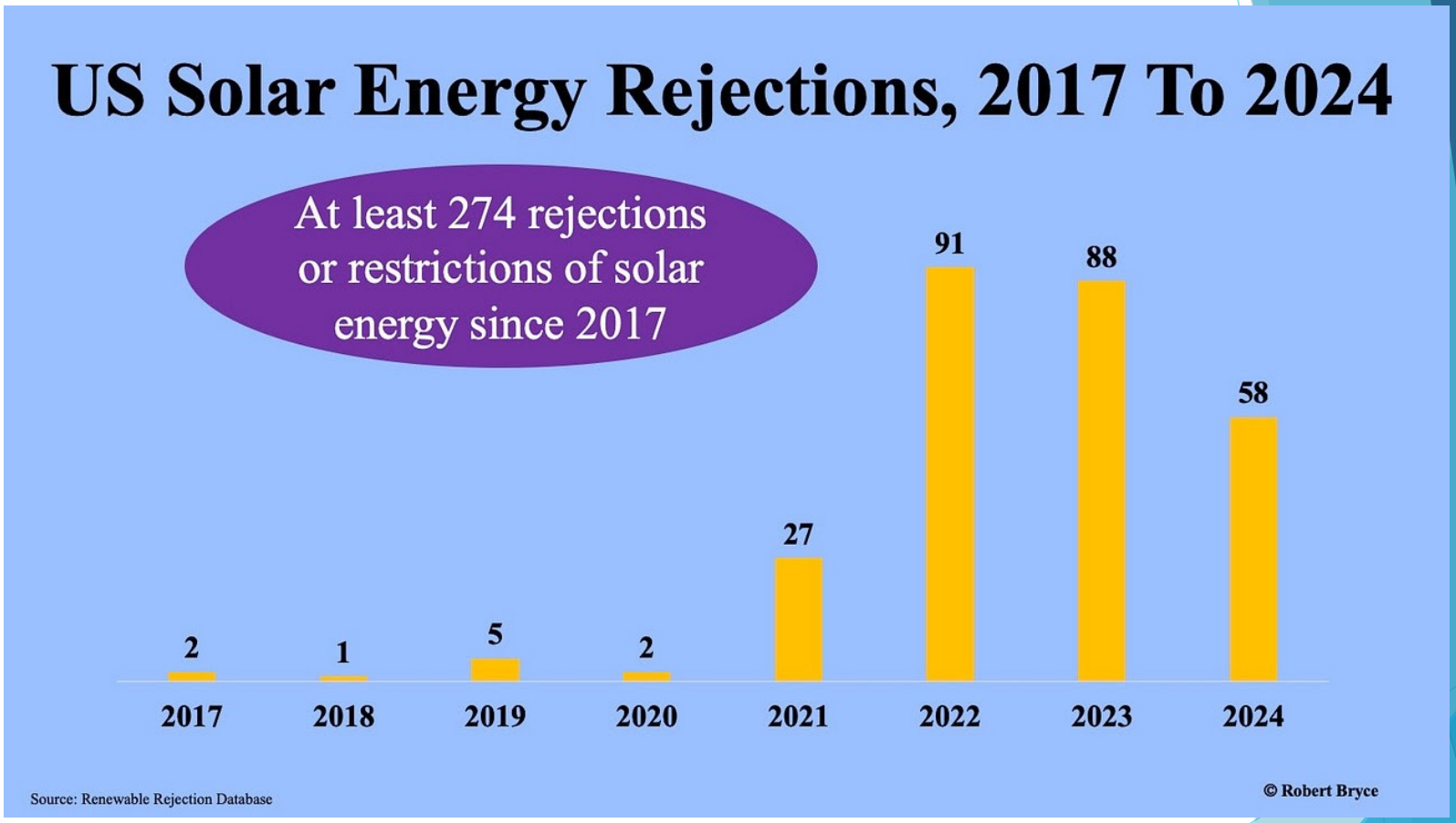
US Solar Energy Rejections, 2017 To 2024



Source: Renewable Rejection Database

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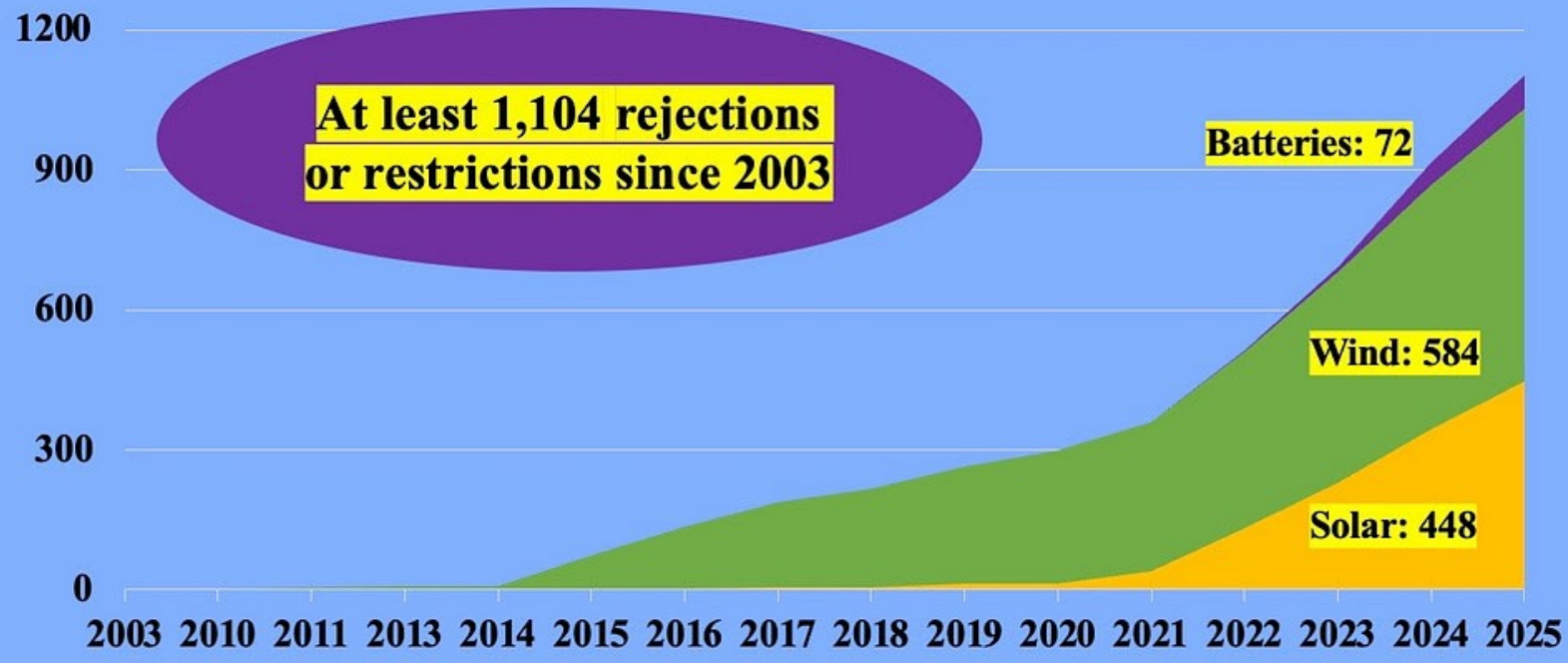
Global Rejections Of Solar, Wind, & Batteries



Source: Renewable Rejection Database

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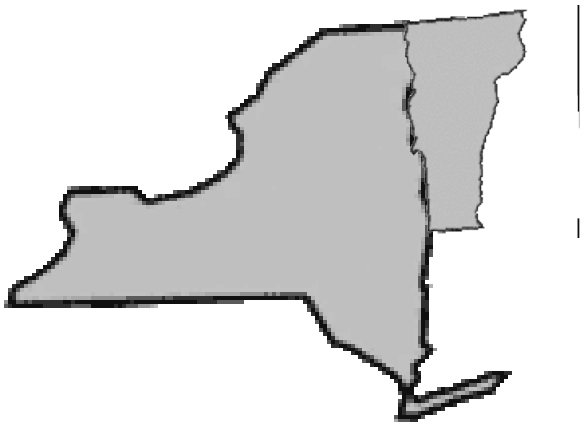
Solar PV Power Reality

- Solar panels may last up to 40 years[1], but high temperatures can accelerate the aging process for solar cells, and snow, dust, and other natural events can cause material fatigue on the surface and in internal electric circuits – gradually reducing a panel's power output.
- Generating all of America's power currently provided by fossil fuel and nuclear power (> 8 billion Megawatt hours) with solar energy would require 18.7 billion solar panels on 57,024 square miles of land[2]

Land Requirements for Generating 1000 MW of Electricity

Method for Generating Electricity	Land Area (sq. miles)
Photovoltaic*	**175 – 235[a]**
Wind*	**530 – 900[b]**
Hydroelectric	**1500[c,e]**
Biomass	**2600[d,e]**
Nuclear	**1.5**

Land Required to Replace U.S. Fossil Fuel and Nuclear Power (2018) with Solar Panels



New York and Vermont[1]

Solar PV Power Reality (cont.)

- Solar panels and their manufacturing processes necessitate many toxic chemicals, including lead, cadmium telluride, copper indium selenide, cadmium gallium (di)selenide, copper indium gallium (di)selenide, hexafluoroethane, and polyvinyl fluoride.[1]
- These processes generate 300 times more toxic waste per unit of energy than nuclear power plants.[2]

Solar PV Power Reality (cont.)

- The Intergovernmental Panel on Climate Change (IPCC) deems NF_3, used in some solar panel construction, to be over 17,000 times more potent than CO_2 as a greenhouse gas.[1]
- Currently, U.S. solar panel manufacturers are not required to, and do not, collect and dispose of solar panel manufacturing toxic waste.

Solar Power End of Life Issues

Solar panels last about 25 y

- Need to dispose of 78 million tons of panels by 2050
- Not appropriate for landfills as they contain toxic materials such as lead and cadmium
- Cost of recycled materials significantly more than raw material cost

Solar Power Facility Hail Storm Damage

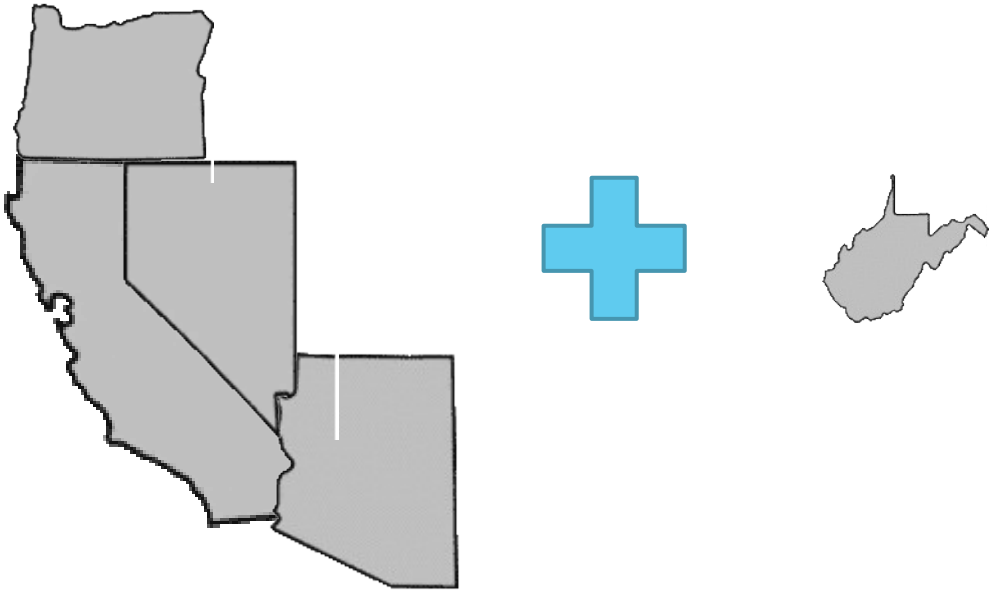
Wind Power Reality

- Actual electricity output is rarely as advertised, often hitting 20% or lower[1], depending on locations – and failing completely on the hottest and coldest days when electricity is most urgently needed.
- Actual wind turbine electricity output declines by 16% per decade[2] of operation – and worse than that offshore, because of storms and salt spray.
- Wind turbine lifetime is about 10 years for offshore turbines, about 20 years for onshore turbines.[3,4]

Wind Power Reality (cont.)

- Standard wind farm supplies full power only with sustained wind speed of about 30 mph, a rare event almost everywhere in U.S.[1]
  - Little to no power generated below 10 mph
  - Low wind systems (high-pressure weather systems) often last a week or longer
- Generating all of America's power currently provided by fossil fuel and nuclear power (> 8 billion Megawatt hours) with wind energy would require 2.12 million turbines on 500,682 square miles of farm, wildlife habitat, and scenic lands[2]

Land Required to Replace U.S. Fossil Fuel and Nuclear Power (2018) with Wind Turbines



Arizona, California, Nevada, Oregon and West Virginia[1]

Wind Power Reality (cont.)

- In 2019, Harvard scientists who believe in a climate crisis published a peer-reviewed article determining that we would have to cover literally one-third of the American land mass with industrial wind projects to replace current electricity generation.
- By those same numbers, we would have to cover an additional one-sixth of the American land mass with industrial wind projects to electrify transportation.

Source: Biden Signs Executive Order Establishing Zero-Emissions Vehicle Targets, *Environment & Climate News*, Vol. 24, No. 05, October 2021

Wind Power Reality (cont.)

- 100 Mw wind farm might cost $100 million to build
  - Average cost of utility-scale backup battery storage facility is about $1.5 million per Mwh[1]
  - One week of backup battery storage for 100 Mw wind farm would cost $25.2 billion
- Colorado currently requires about 10,000 Mw of power during summer peak use times[2]
  - One week of backup battery storage would cost about $2.5 trillion
  - Colorado's governor calling for 100% renewables by 2040

Wind Power Reality (cont.)

- There are significant environmental costs associated with mining and refining rare earth elements for wind turbines (approximately one ton of neodymium magnets per 5-MW generator).[1]
  - 95% of world's rare earth materials production occurs in China, which has few industry pollution controls
  - Processing of rare earth elements creates radioactive waste byproduct
  - Resulting negative effects on China's environment have been largely ignored by renewable energy advocates

Wind Turbine Health Issues

Infrasound

- Sound wave with frequency less than 20 hertz (human audible threshold about 16 Hz)
- Emitted by larger wind turbines (larger the turbine, lower the frequency)
- Can penetrate walls, people and animals
- Mechanical forces from inaudible frequencies affect cell and membrane structures

Wind Turbine Health Issues (cont.)

Infrasound (cont.)

- Canadian Family Physician Journal cites research reporting adverse effects of industrial wind turbines including weakness, dizziness, headaches, concentration and memory issues, ear pressure, cardiac arrhythmia, and sleep disorders

Wind Power End of Life Issues

Wind turbine blades last about 10 years and are expensive to decommission and transport.[1]

- Blades must be cut into smaller pieces onsite, using specialized equipment, before being transported to a landfill.
- Certified municipality landfills are increasingly rejecting these blades because they take up tremendous amounts of space, must be crushed at considerable expense, and take hundreds of years to decompose.

- Wind turbine decommissioning costs run about $500,000 per turbine.

What About Reliability?

NERC "ERO Reliability Risk Priorities Report," August 17, 2023:

2023 Risk Ranking

America's electric generation capacity "is increasingly characterized as one that is sensitive to extreme, widespread, and long duration temperatures as well as wind and solar droughts."

Source: https://www.nerc.com/comm/RISC/Related%20Files%20DL/RISC_ERO_Priorities_Report_2023_Board_Approved_Aug_17_2023.pdf

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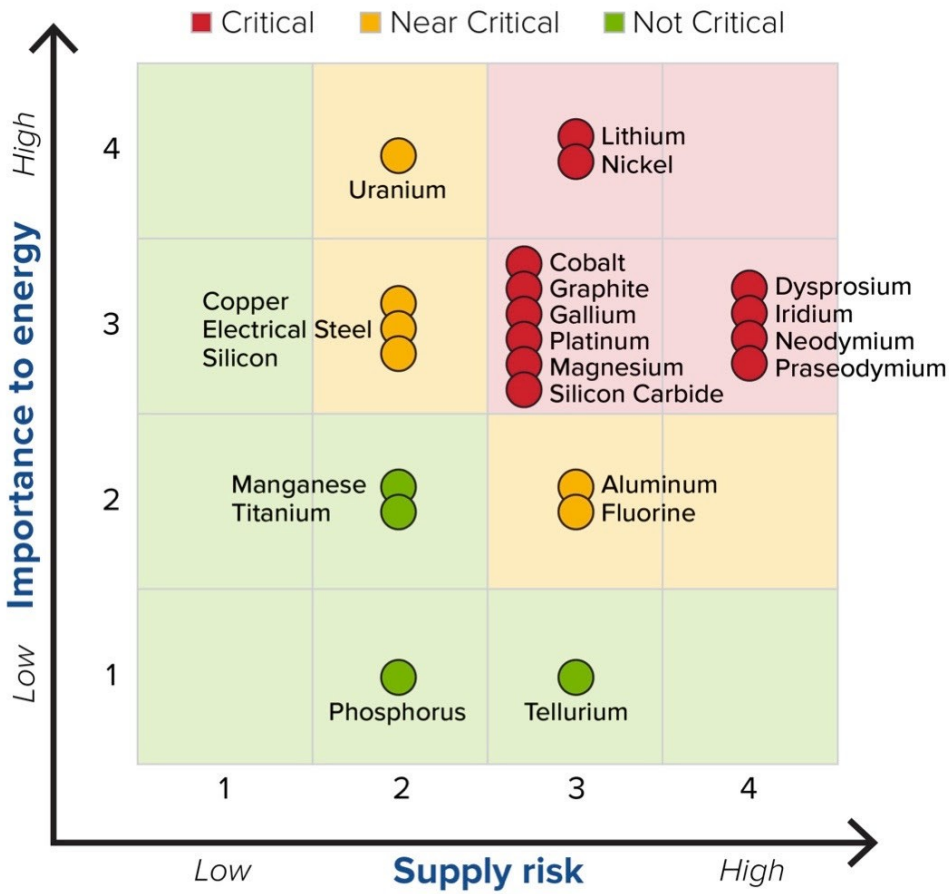
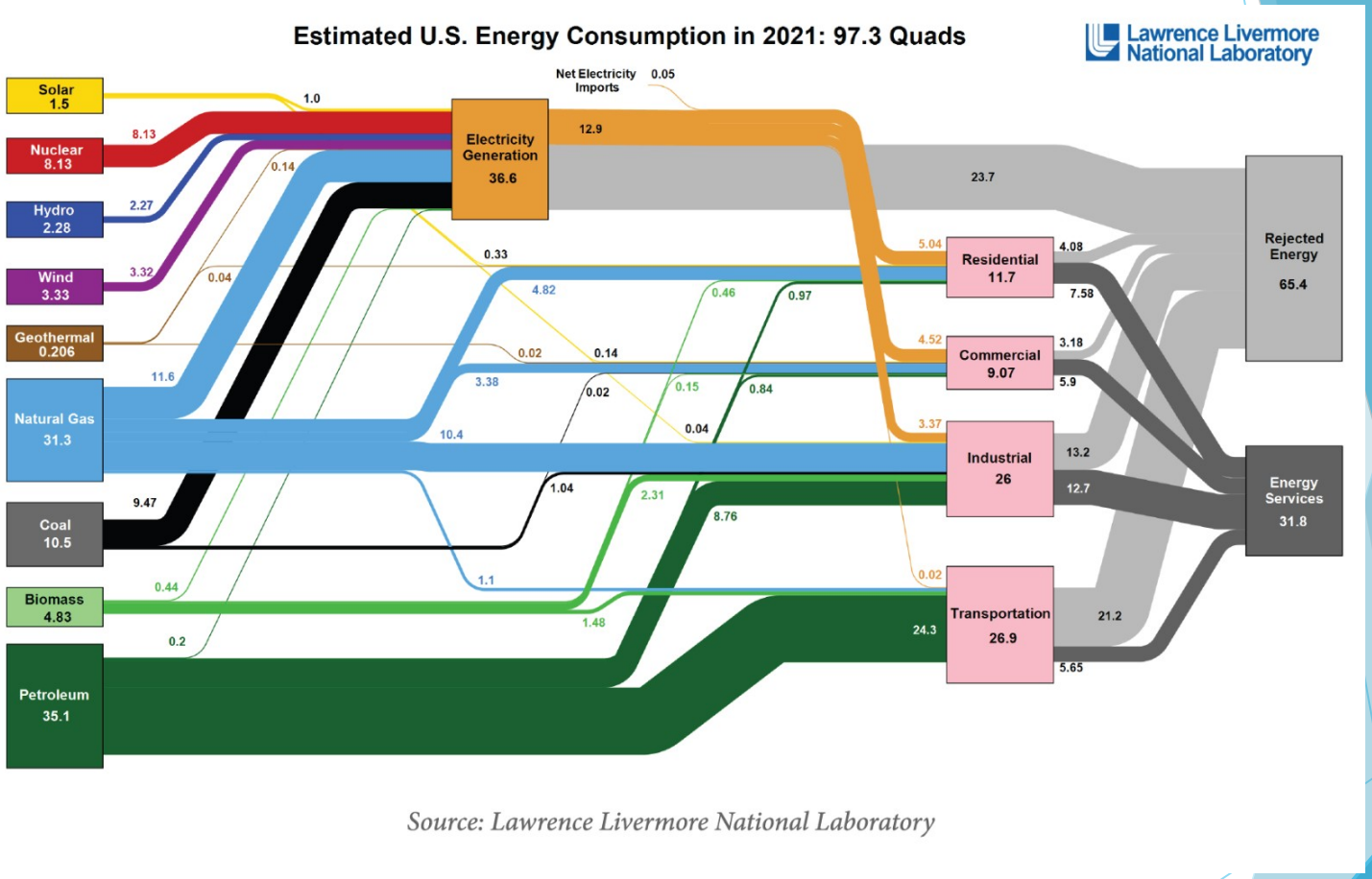


Figure 3.2 Medium-term (2025–2035) criticality matrix

Electric Vehicle Issues

- Poor range – particularly in cold climates
- Long charging times
- Wastes from production of EV batteries
  - Batteries made from “rare earth” and other toxic heavy metals
- Toxic waste from disposal of batteries at end of useful life (5-8 years)



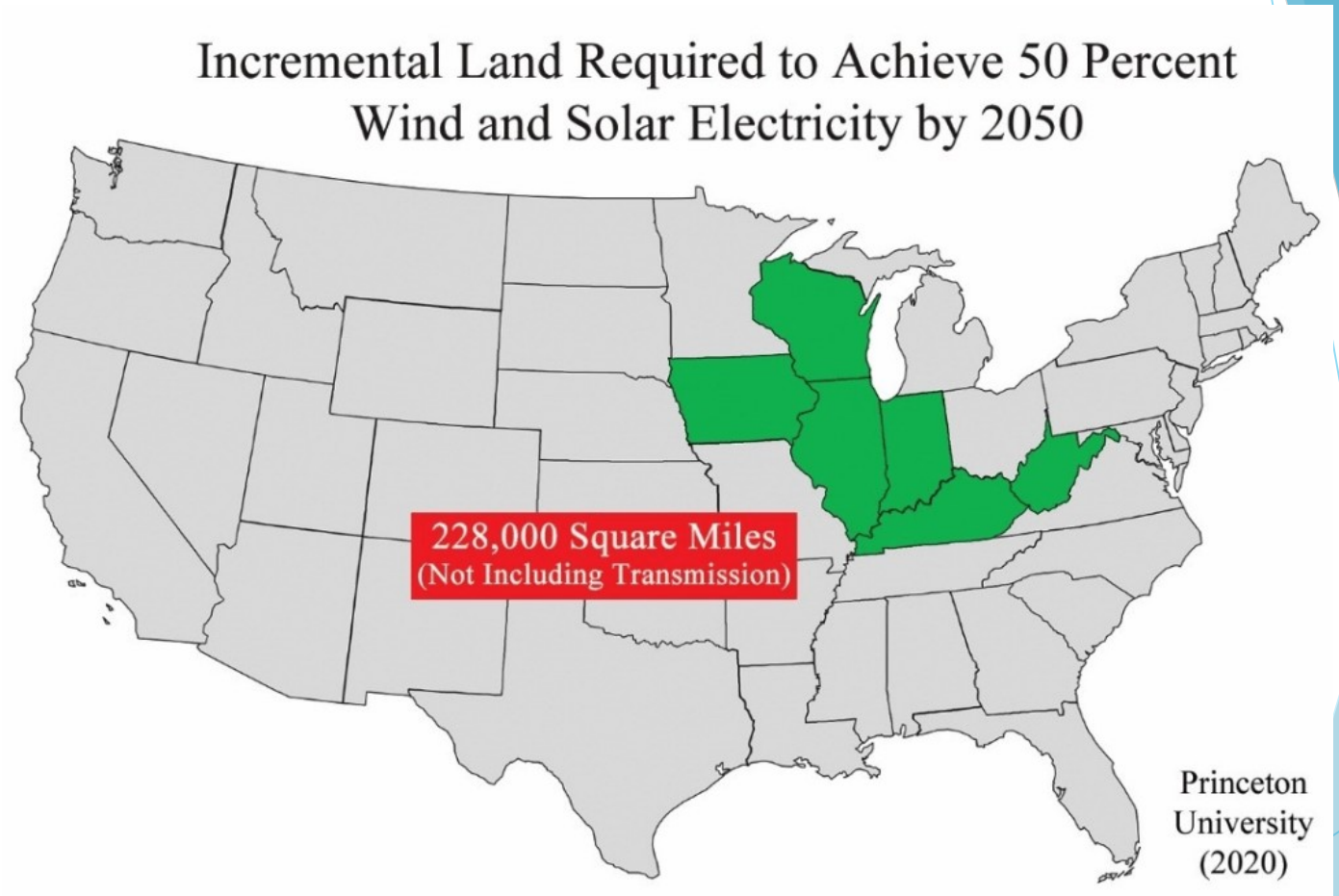
Source: Lawrence Livermore National Laboratory

Lithium Battery Facts

Machine like this required to move 500 tons of earth and lithium ore to get lithium for one car battery

Burns **900-1000 gallons of fuel** in 12- hour shift

Lithium refined from ore using sulfuric acid creates very toxic waste


Incremental Land Required to Achieve 50 Percent Wind and Solar Electricity by 2050
228,000 Square Miles
(Not Including Transmission)
Princeton University (2020)

Can You Go a Day Without Fossil Fuels?

https://www.youtube.com/watch?v=jnqVNpZkzuI